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DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Process and Apparatus for Producing Thermoplastic Articles.

I, KARL MAGERLE, a Swiss Citizen, of 1, Im vorderen Erb, Küsnacht, Zurich, Switzerland, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a process and apparatus for producing thermoplastic articles.

It is known to produce, for instance, tubes from a tubular thermoplastic blank by the tube upper part being formed on the end of thef tube body by stamping, a core being used to retain the blank, while a moulding tool comprising heating and cooling means co-operates with the core. It it also known to mould tubes by means of a plunger and of a stamping tool by a procedure wherein a preshaped annular plastic member is introduced into the stamping tool, whereafter the plunger and stamping tool are moved together to form the tube upper part first, whereafter the tube body is formed by the plastic being displaced through the annular passage between the plunger and the stamping tool.

It is an object of the process according to this invention to prepare hollow articles by a moulding process wherein a core is used which may or may not also serve to retain a tubular blank, a moulding tool co-operating with the core. According to the invention a method of producing a thermoplastic article includes the steps of ejecting a predetermined quantity of plastics material in a temporary state of relatively low viscosity from a hollow feeder member on to a support surface, relatively moving a die along the feeder member towards a core, such die being arranged to scrape ejected plastics material off the feeder member, closing the mould constituted at least partly by the die and the core, and moulding the article by moving the die relatively to the core into moulding contact with the plastics material.

The invention consists also in apparatus for performing the method defined above, the apparatus having a core and a composite moulding device including a hollow feeder member and a die, wherein the feeder member is adapted to eject a predetermined quantity of plastics material in a temporary state of relatively low viscosity in a direction towards the core through a number of apertures at the end of the feeder member adjacent to the core, wherein the die is adapted to be moved along the feeder member towards the core and to scrape ejected plastics material off the feeder member, and wherein the die and the core constitute at least partly a mould which is adapted to be closed by relative movement between the die and the core.

For a better understanding of the invention and to show how the same may be carried into effect, reference may now be made to the accompanying drawings wherein:—

Fig. 1 is a view, partly in section and partly in elevation, of a first embodiment;

Fig. 2 is a view, partly in section, of a second embodiment;

Fig. 3 is a part sectional view taken along the line III—III of Fig. 2;

Fig. 4 is a part section through an embodiment similar to Fig. 2 but comprising means for producing a tube with a small aperture;

Fig. 5 is a vertical part section through the feed plunger and the first moulding die of a third embodiment;

Fig. 6 is a vertical part section taken along the line VI—VI of Fig. 5;

Fig. 7 is a side elevation of a fourth embodiment;

Fig. 8 is a horizontal part section taken

along the line VIII—VIII of Fig. 7;

Fig. 9 is a vertical part section, to an enlarged scale, through the feed plunger and first moulding die of the fourth embodiment;

Fig. 10 is a horizontal section taken along the line X—X of Fig. 9;

Figs. 11—16 illustrate three different moulding dies for producing screwthreads;

Fig. 17 is a vertical part section through a fifth embodiment in the first stage of forming a blank; and

Fig. 18 is another view in vertical part section showing the final shaping of the article in the second stage.

Referring to Fig. 1, a feeder member 1 is disposed at the forward end of a cylinder 9. Disposed therein is a piston 10 adapted to convey a plastic composition 11 through a holow interior 8 of feeder member 1 to apertures 4. The same are disposed about the periphery at the forward end of feeder member 1, for instance, in the form of six bores spaced 60° apart from one another. A core 3 is adapted to receive a piece of plastic tubing 6 and is shaped to form at its free end a matching or co-operating moulding section or plunger 2 which co-operates with feeder member 1, has the same diameter as the latter and is disposed on the same axis. The interior of a mould 19 has the shape of the required tube upper part. The matching plunger 2 projects so far from the core 3 as to be able, when the mould is closed, to mould the interior of the tube neck. The outer part of the tube neck is moulded by two movable mould elements 17 adapted to move radially in relation to the common central axis of feeder member 1 and moulding section 2 of core 3. Pistons 18 moving in cylinders 12 are connected by rods 21 to the mould elements 17. A pressure medium, such as compressed air or water under pressure, is supplied to the cylinders 12 through connecting pipes 20, 22. A carriage 13 is formed with passages 23 in which a cooling liquid serving to cool the mould elements connected to the carriage 13 can flow. Moving in cylinders 14 are pistons 15 having rods 16 to which carriage 13 is rigidly secured. The cylinders 14 are secured to machine frame 7. Pressure medium to operate the pistons 15 is supplied through pipes 28 to the cylinders 14.

The apparatus illustrated in Fig. 1 operates as follows:—

A measured portion of plastic tubing 6 is engaged on the core 3 in known manner with the end of the tubing 6 projecting beyond the front edge of the core 3 in the manner shown in the lower half of Fig. 1. The lower half of Fig. 1 also shows the second step in the process—i.e., the introduction of plastic 11 through the hollow interior 8 and the apertures 4 into engagement with the inner wall of the tubing 6 while the mould still remains open. After the advance of the piston 10 to introduce plastic, the mould elements 17 are moved towards one another laterally by the pistons 18 so that the die portion for moulding the tube neck is prepared for pressing. The passages 4 at the forward end of the feeder member 1 extend obliquely forwardly and outwardly from the interior thereof. The streams of plastic which issue from the feeder member 1 through these passages are therefore directed towards the inside of that part of the plastic tubing 6 which projects beyond the core, and at the place where such streams contact the inside of the tubing 6, accumulations 24 are formed which become welded immediately to the tubing 6. After the predetermined quantity of plastic required to produce the tube upper part has been ejected from plunger 1 whilst the mould is still open, the cylinders 14 move the carriage 13 into the position shown in the top part of Fig. 1. As the carriage 13 advances, any strands of plastic still sticking to the feeder member 1 are scraped off by the mould elements 17 or, more precisely, by closure portions 29 thereof. The core 3 with the plastic tubing 6 on it and with the accumulations 24 stays where it is.

The end position of the carriage 13 during pressing is shown in the top part of Fig. 1. When the mould 19 touches the end of the tubing 6, the latter is moved back until abutting an abutment (not shown in Fig. 1), the accumulations 24 being pushed into a recess 30 formed between the shoulder of the core 3 and the tubing 6. Tube upper part 25 is formed by the plastic accumulations 24 being displaced from their position towards the neck part, the matching plunger 2 forming the core for the outlet of the finished tube. When the plastic in the mould has set, the mould elements 17 are withdrawn by the pistons 18 so that the carriage 13 can return to its initial position, the core 3 with the finished tube on it being exposed so that the finished tube can be removed from the core 3 in known manner.

Fig. 2 illustrates a second embodiment of the apparatus for performing the same process. Basically, the second embodiment is the same as the embodiment illustrated in Fig. 1. A feed plunger 31 is disposed at the forward end of a cylinder 32 and has passages 33 through which plastic 34 can be displaced from the interior of the cylinder 32. Heating means and temperature control means of the kind conventional in plasticising apparatus are not shown in Fig. 2, nor are dispensing means for dispensing a measured quantity of plastic. Any of the known dispensers can be used for this purpose. A carriage 35 is adapted to move in the direction of the centre axis of the cylinder 32 and is driven in known manner by a

piston 36 operated by a pressure medium. A mould 37 is secured in the carriage 35 by means which are not shown. A core 38 comprising a matching plunger 39 adapted to co-operate with the feeder member 31 is also disposed along the centre axis of the cylinder 32. A measured portion of plastic tubing 40 can be placed on core 38 with the end of the plastic tubing 40 extending beyond a shoulder 41 of the core 38. Two pairs of moving slides 42, 43 are connected by slideways to the mould 37. At its forward end, each slide 42 comprises that section of the mould which produces one half of the screwthreaded neck part. Slide 43 has a straight closure at its forward end and in co-operation with the similar slide 43, can completely close the mould when the carriage 35 has advanced from the region of the feed plunger 31. The advance and return movement of slides 43 is controled by cylinders 44, and a cylinder 45 is provided to control the advance and return movement of each slide 42. A cooling duct 46 removes heat from the carriage 35 and mould 37 in known manner. A scraper plate 47 is rigidly secured to the slide 42 and is formed at its forward end with a semi-circular recess.

The second embodiment illustrated in Figs. 2—4 operates as follows:—

First, a measured portion of plastic tubing 40 is so placed on the core 38 that the forward end of the tubing 40 projects beyond a shoulder 41 of the core 38 and cooperate with shoulder 41 to form a recess. The initial position of the carriage 35, in engagement with abutment 48, is shown in the left-hand portion of Fig. 2. A piston in cylinder 36 is capable of moving carriage 35 as far as abutment 53. When carriage 35 is in its initial open position, the feeder member 31 extends into the mould 37. A dispenser is then operated to force plastic at low pressure through the passages 33 onto the inside of the plastic tubing 40, the quantity of plastic injected being such that the tube upper part can be formed from it by pressing. The plastic thus introduced forms the first weld spots 49 for welding to the tubing 40 the tube upper part which will subsequently be formed. In the next operation, the pairs of slides 42, 43 are moved towards one another by the cylinders 44, 45, the scraper plate 47 engaging around the feeder member 31, while the straight edges of slide 43 engage with plunger 31. The carriage 35 bearing the mould 37 and the slides 42, 43 therein is then advanced as far as abutment 53, the pistons 44 compelling the slides 43 to close once the same have moved beyond the forward end of the feeder member 31. The mould is thus closed on all sides, whereafter the plastic which has issued from the passages 33 and which is already slightly set is separated from the feeder member 31 by the scraper plate 47 and moved forwards.

Referring to Fig. 3, the left-hand side thereof comprises a section through the cylinder 45, slide 42 and feeder member 31. The right-hand half of Fig. 3 is a section through slide 43 and a plan view of cylinder 44 which moves slide 43. The same completely closes the tube neck part so that a closed tube can be moulded. The slide 43 must be closed during the advance of the carriage 35 so that the neck part of the tube mould has been closed before the material which has accumulated at the place 49 is pressed towards the neck of the tube. As will be apparent from the right-hand half of Fig. 3, the slide 43 is guided in a groove in the slide 42. Pivot pins 50 serve as connecting element between driving rods 51 and slide 43.

A variant of the embodiment illustrated in Figs. 2 and 3 is illustrated in Fig. 4 and differs from the previous embodiment in that a matching plunger 56 which co-operates with the feeder member receives a pin 57 engageable in a passage 58 in slide 59. Slides 60 bear moulds for the neck part and a screwthreaded extension 61 of the tube. The pin 57 is of a length such as to enter the passage 58 before the plastic has been conveyed by pressure into the neck part of the tube. If required, the apparatus can be so devised that the carriage remains stationary during pressing while the core moves axially. The cylinder comprising the feeder member can be moving or stationary, just as required. Conveniently, the core is disposed on a turntable which bears a number of cores, in order that the flexible tubing and the finished tubes may be loaded and unloaded without causing a loss of time in the pressing process.

The advantage of the process hereinbefore described over the processes previously used is that, with the mould open, the flexible tubing can be advanced on the core sufficiently for plastic to be introduced satisfactorily on to the inside of the flexible tubing and on to the proposed weld zone. This ensures that plastic does not extend beyond the edge of the tubing and reach the outside thereof. Quite the contrary, indeed, for at the start of pressing the plastic which has been introduced is pressed tightly into the recess between the flexible tubing and the core shoulder. Another considerable advantage provided by the invention is that the plastic is fed to the inside of the flexible tubing without contacting the cooled surfaces of the mould and is brought to the weld zone without further temperature loss. The weld between the tube upper part and the inside of the tubing is performed substantially at the temperature at which the

hot plastic is introduced from the dispenser. During pressing, surplus plastic is displaced upwards and contacts the cooled surfaces, so that when the plastic penetrates into the tube neck part, such plastic has cooled a little but is still readily mouldable. This is desirable because the neck part of the tube mould comprises moving mould elements which are difficult to cool. In the process according to this invention, the plastic is hottest in the places where welding must be performed, and is coolest at places where moulding requires a lower temperature than at the weld zone and where, because of the presence of moving elements, it is difficult to cool the mould. Introducing the plastic on to the inside of the flexible tubing assists welding because, from the inside of the flexible tubing, the plastic can be distributed more rapidly and with a minimum of displacement of material along the surface of the tube. Since welding improves in proportion as the number of places on the tubing periphery where plastic streams are received is increased, it is advantageous for the feeder member to have more than one ring of passages. The provision of a second such ring on the feeder member provides the advantage that extra reception zones for plastic streams can be utilized between the zones associated with the first such ring. The increased number of passages leads to better dispersal of material over the tubing periphery and therefore to improved welding.

Referring now to the third embodiment, which is illustrated in Figs. 5 and 6, there can be seen an apparatus in which a tapped cap 101 for closing containers can be produced by the process according to the invention. A feeder member 102 is disposed at the forward end of a cylinder 103. Disposed therein is a dispensing device comprising a piston 104 adapted to convey a plastic composition 105 through the hollow interior 106 of feeder member 102 to passages 107. The same are disposed at the forward end of feeder member 102 in a ring, for instance in the form of six passages spaced 60° apart from one another. The end of a core 108 acts as inner mould for the required cap 101. A moulding die 109 is used for the first step in the process and forms a part of the mould for the outer shape of the cap 101. Die 109 is secured in a carriage 110 and moves therewith. The guides for carriage 110 are not shown in Fig. 5 and can be of known design. Carriage 110 is moved by means of cylinders 111, pistons 112 and piston rods 113. Piston 112 is operated by a pressure medium which is supplied and removed through piping 114. Cylinders 111 are secured to machine frame 115. Rigidly secured to cylinders 111 are two more cylinders 116 having pistons 117 which, by way of linkage 118, move a sleeve 119. The inner diameter thereof corresponds to the outer diameter of feeder member 102, so that sleeve 119 can be moved in the direction of the longitudinal axis of feeder member 102. Sleeve 119 serves to close passages 107 and also to part off the plastic strands issuing from passages 107. An entraining pin 120 serves as connecting member between sleeve 119 and linkage 118. Carriage 110 comprises passages 121 for conveyance of coolant. Similarly, carriage 110 is provided with cylinders 122 having pistons 123 and piston rods 124 serving to move paws 125. Pressure medium is supplied to and removed from cylinders 122 through piping 126. Closure members 127 for cylinders 122 comprise a passage through which piston rod 124 can extend. A closure ring 128 is longitudinally movable on core 108. Springs 130 which bear against a ring 131 thrust ring 128 against stop pins 129. Ring 131 is prevented from moving on core 108 by lockscrews 132.

The apparatus illustrated in Figs. 5 and 6 operates as follows:—

Initially, carriage 110 is in the open position shown in the bottom half of Fig. 5, the piston 112 being under pressure on the carriage side and thrusting the carriage against abutments 133. Jaws 125 are also in the initial open position because pistons 123 are under pressure on the side of jaws 125. Pistons 117 are also experiencing pressure on the side of carriage 110 and prevent sleeve 119 from moving towards carriage 110. Core 108, which is disposed on a turret or on some form of conveying device adapted to move the core axially, is moved into the operative position shown and locked by an indexing device against lateral and axial movements. Cylinder 103 comprising piston 104 is filled with plastic composition and in known manner heated to a temperature at which the plastic can be forced through the passages 107 which are disposed in a ring round the end of core 108. As first step, piston 104 forces a predetermined quantity of plastically deformable pjlastic through the hollow interior 106 of feed plunger 102 and through passages 107 so that the plastic forms a ring around the end of core 108; subsequently through the agency of linkage 118, pistons 117 move sleeve 119 towards core 108, the forward edge 134 of sleeve 119 parting off the strands of introduced plastic on the outward side of passages 107. For the next step, carriage 110 is moved towards core 108 by pressure medium which enters cylinders 111 behind pistons 112. During this movement of carriage 110, pressure medium is also operative on the outward cylinder side of pistons 123 and the same move jaws 125 axially to-

wards one another. As can be seen in Fig. 6, jaws 125 abut each other along a straight line 135, thereby closing tightly the mould cavity 136 in which the cap 101 is to be formed. This closure is effected during the forward movement of carriage 110 once jaws 125 have moved away from the region of feed member 102. The complete die comprising the elements 109 and 125, starts to mould the introduced plastic by a stamping or pressing process, together with the end of core 108. When die 109 contacts ring 128, the mould for the cap 101 is in the closed state. The final shape of cap 101 is reached when the ring 128, moving against the force of springs 130, abuts pins 129.

Carriage 110 starts its return movement before the plastic in the mould elements 136 has fuly set. According to the process and apparatus provided by this invention, frequently neither the die 109 nor the jaws 125 have the dimensions of the final article but have generally or partially larger dimensions. Upon the completion of the return movement of carriage 110, core 108 with the initially pressed workpiece on it—in the present case, the cap 101—is moved away from the dies 109 and towards a second moulding die which is not shown in Figs. 5 and 6. The hot and still plastic substance forming the cap 101 is given further shaping treatment in the second moulding die. Such further shaping treatment may be final or may have to be completed in a third moulding die or possibly in further moulding dies. A system for transfer shaping is illustrated by way of example in Figs. 7 and 8.

A feed device 140, of the kind described with reference to Figs. 5 and 6, is secured to a plate 141 connected by sleeves 142 to guide rods 143. A baseplate 144 determines the position of the four guide rods 143 and also bears a rotatable table 145 to which eight cores 146 are so secured as to be rotatable stepwise around central axis 147. A table 149 moves along guide rods 143 with the interposition of guide sleeves 148. Moulding dies 150—152 are mounted on table 149. Through the agency of rods 153, a drive (not shown) moves table 149 with the moulding dies 150—152 thereon. In the present example, the second moulding die 151 and the third moulding die 152 can additionally be moved individually and independently of one another and also of the first die 150 in the direction of movement of table 149. In Fig. 7 there can be seen a rod 154 for moving die 151 and a rod 155 for moving die 152. The corresponding pistons and cylinders have the respective references 156 and 157 in Fig. 7. Also shown therein, in diagrammatic form is a hydraulic drive 158 which provides the stepwise motion of table 145. All the stations of the cores 146 are shown in Figs. 7 and 8. Removing devices to remove the finish-moulded and cooled caps are not shown and can work in known manner and in accordance with various principles. Whereas die 150 is rigidly secured to table 149 and always moves together therewith in the example illustrated in Figs. 7 and 8, dies 151 and 152 can be moved individually and independently of one another. Alternatively, all the dies 150—152 can be arranged for individual and independent movement and operation. As another alternative, the first die can be adapted to move independently of the second and other dies, while the second and other dies are movable only together. In the apparatus illustrated in Figs. 7 and 8, a number of cores in a turret arrangement and at least two moulding dies are provided, the latter being arranged for transfer working with various mould interiors. The moulding dies have their central axes arranged on a circle so that each core can co-operate consecutively with each moulding die to form a mould. Alternatively, cores disposed in a turret arrangement on a rotating table can be arranged for axial movement. Conveniently, if the cores are screwthreaded, each core is arranged to rotate around its own axis, to speed up the pulling-off of the moulding and the removal from the core.

As regards operation, in the first phase the apparatus illustrated in Figs. 7 and 8 is identical to the apparatus illustrated in Figs. 5 and 6. After a measured quantity of plastic has been introduced by feeder 140 into die 150, table 149 is moved towards core 146, a preshaped cap being formed, whereafter table 149 with die 150 rises. The hydraulic drive 158 advances the rotating table 145 by one increment—i.e., by 45°. The next core 146 therefore moves below die 150, whereas core 146 bearing the preshaped cap is below die 151. During the next movement of table 149, die 150 produces another preshaped cap while die 151 gives the cap just produced a second pressure treatment. During the next movement of table 145, the first produced cap is moved below die 152 while the second cap moves below die 151. During the next pressing movement of table 149, the first cap is brought to its final shape and size by die 152, while die 151 gives the next cap the second pressure treatment. During this movement, die 150 has produced a third initially pressed cap.

Another embodiment of the apparatus according to this invention is illustrated in Figs. 9 and 10. This apparatus is very suitable for producing thermoplastic tubes; in it, an upper part is preshaped by pressing from a measured quantity of plastic feed and is simultaneously welded to the end of an introduced measured piece of plastic tubing. Only a cylinder 161 and feeder mem-

ber 162 can be seen in Fig. 9 of the feeder which is shown in Fig. 5 and which has been described with reference thereto. The plastic feed 163 is brought in known manner by heat and pressure to a state in which it can be expressed through passages 164 by brief pulses of pressure. The axes of the passages 164 so extend that the plastic issuing through the passages is disposed ringwise on a core 165. The portion of plastic tubing 166 is so placed on the core 165 that the end of tubing 166 extends beyond the shoulder of core 165. A plunger 167 at the end of core 165 forms the inside of the neck part of a tube. A moulding die 168 is secured in a carriage 169 moved by two pistons disposed in cylinders 170 and connected to carriage 169 by piston rods 171. Limit stops 172 locate the carriage 169 in its normal position, and limit steps 173 locate carriage 169 in a position for pressing. Carriage 169 has passages for a coolant. Also, slides 175 are disposed in carriage 169 and can move radially in relation to the central axis of core 165 and feeder 162. On those of their sides which are near one another, the slides 175 comprise a mould for a screwthread. One plate 176 each is disposed on the top of each slide 175 and is formed with a semi-circular recess of the same diameter as feed plunger 162 and matching plunger 167. Cylinders 177 receive pistons 178 having piston rods 179 rigidly secured to slides 175.

The embodiment illustrated in Figs. 9 and 10 operates as follows:—

A measured portion of plastic tubing 166 is engaged over core 165 in known manner, with its end extending beyond the shoulder of core 165 as can be seen in the left-hand part of Fig. 9. In the initial position associated with the production of a tube, the carriage 169 is in the position shown on the left-hand side of Fig. 9, the back of carriage 169 being in engagement with limit stops 172. While the mould is still completely open, strands of plastic 163 are fed through the passages 164 in feeder member 162 and engage ring fashion around the inside of the plastic tubing 166. During the next step of the process, the slides 175 are engaged by the pistons 178 with the feeder member 162 so that the plates 176 engage closely around the external diameter of feeder member 162. The carriage 169 is then advanced by the two cylinders 170 and the pistons therein, with the result first that the ring of plastic strands which have issued from passages 164 and which are partly set is scraped off and pushed forwards. As carriage 169 continues to advance, the mould closes, the moulding die 168 engaging around the top part of the plastic tubing 166 and co-operating with the screwthreaded mould in the interior of the slides 175 and with the top of the core 165 to form a complete mould.

In the process according to this invention, pressing is not complete when the steps just described have been performed, for the internal shapes of the moulding die 168 do not correspond to the final dimensions of the required tube. The carriage 169, when in the position for pressing, has its front in engagement with the stops 173. Immediately upon the completion of the advance of the carriage 169, the slides 175 with the plates 176 secured thereto are pulled radially outwards by the pistons 178 and thus release the neck of the newly formed tube. The carriage 169 is returned to the normal position, whereafter the core 165 with the semi-finished tube 180 on it is moved away from the first moulding die 168 and is given further moulding treatment, for instance, by a system similar to that shown in Figs. 7 and 8, in a second and possibly a third or more moulding die or dies. Upon completion of the various stages of pressing, a finished tube 180 is pulled off core 165 by means which are not shown and which are known, and is removed.

A description will now be given of the process and means by which, in accordance with this invention, a tube or some other article can be provided with a finished screwthread by transfer pressing.

The condition of the screwthread upon the completion of the first stage of pressing is shown in Figs. 11 and 12. As will be clearly apparent from Fig. 12, a cross-section through the screwthread in the two slides 181, 182 is an oval, the minor axis of which coincides with the gap between the two plates 181, 182. The major axis of the oval is disposed in the direction of movement of the two plates 181, 182. Fig. 11 illustrates a portion of the screwthreaded part upon completion of the first stage of pressing: it will be apparent that a screwthreaded profile 183 of about one-third of the depth of the final screwthread has been formed in a plastic composition 184. At the termination of the first stage of pressing, the plastic is still hot enough not to retain exactly the impressed shape of screwthread upon leaving the slides 181, 182. Slides 185, 186 associated with a second stage of pressing have a screwthread cross-section which is more circular than the screwthread cross-section of the slides 181, 182. Only those parts of the screwthread which are near the boundary between the two slides 185, 186 are appreciably bulged out, and the still plastically deformable plastic can be displaced into such bulge during the second stage of pressing. The direction in which the slides 185, 186 move is offset by 45° from the direction in which the slides 181, 182 of the first mould move, in order that the plastic may be made to flow local to the neck part by

the second pressing operation. Fig. 13 shows that a much clearer screwthreaded shape results at the completion of the second pressing operation. The plastic 188 has been moulded to the full depth of the screw thread 189. A flash is deliberately formed at places 187, visible in Fig. 14, during the second pressing operation and takes up the plastic displaced by the increased depth of the screwthread. The volume of the flash parts 187 is such that the slides 185, 186 cao be pressed flush against one another. At the completion of the second pressing operation, the screwthread has its final diameter in the direction of movement of the slides 185, 186.

Slides 190 and 191 of the third stage of pressing, shown in Figs. 15 and 16, are shaped to provide the final screwthread. The two slides 190, 191 move in a direction perpendicular to the direction in which the slides 185, 186 move, to ensure finish moulding of the flashes 187. Fig. 15 shows how the screwthreaded shape 193 formed in the plastic 192 has not altered from the shape shown in Fig. 13.

The embodiment illustrated in Figs. 17 and 18 is for two-stage moulding of a plastic cap, for instance, for a bottle closure member. The article is produced on a rotating table apparatus comprising a number of stations; the station illustrated in Fig. 17 is for producing a blank, while the station illustrated in Fig. 18 is for shaping the blank into a partly or fully finished cap. As in some of the embodiments hereinbefore described, the dies are disposed on an axially movable rotating table (not shown) which moves stepwise past a single plunger or merely one plunger per set of moulds. A mould 201 for preparing blanks can be seen in Fig. 17; in the left-hand part thereof, the mould 201 is shown in the position for introduction of a plasticised feed by a feeder member 202. That position of the mould which is to the right of the centre line corresponds to the state at the end of the operation of moulding a blank 203. A sleeve 204 is received in mould 201, engages in an annular groove 205 and is telescopically guided therein. Inner wall 206 of sleeve 204 co-operates with annular surface 207 to bound the mould interior. Distributed over the periphery of sleeve 204 are a number of passages 208 extending parallel with the sleeve axis and receiving helical springs 209 which bear against the base of groove 205 and tend to maintain the sleeve or bush in a pushed-forward normal position determined by limit stops (not shown).

By way of a top enlarged part 210, feeder member 202 communicates with a device for supplying an accurately measured quantity of plasticised feed, such as a cylinder and piston described with reference to the examples hereinbefore described. Local to its bottom end, member 202 has a number of exit passages 211 which are uniformly distributed over its periphery and which communicate with the dispenser through a passage extending through the interior of the member 202. Mould 201 co-operates with a core 212 on which a bush 213 can move telescopically. As is apparent from Fig. 18, bush 213 bears, by way of helical springs 214 in passages 215, against a stop ring 216 which can be adjusted by an adjusting screw 217 relatively to core 212. In Fig. 17, the sleeve 213 is shown in its inoperative position in which it is prevented from movng further up towards the mould by limit stops (not shown). Sleeve 213 is formed at the top with a widened bore 218 which co-operates with the core 212 extending therethrough to bound an annular chamber 219, the purpose of which will be described in greater detail with reference to Fig. 18.

As already mentioned, the position in which the elements are shown on the left-hand side of Fig. 17 corresponds to the start of working; the feeder member 202 extends through a central bore 220, while the feeder passages 211 are outside the mould interior formed by the surfaces 206 and 207. With the mould 201 in this position relatively to the feeder member 202, the desired quantity of plasticised feed is expressed by the dispenser through the passages 211 in the form of slugs 221 which initially stick to the feeder member. The mould 201 is then moved axially by the rotating table—i.e., the mould 201 is moved towards the core—the inner wall of passage 220 closing the passages 211 in the feeder member 202, scraping the slugs 221 off the same by means of the surface 207, and finally co-operating with core 212 to close the mould interior. The important thing in this procedure is that the sleeve 204 meets conical surface 222 of core 212 and therefore closes the mould interior before the plastic starts to be shaped—i.e., before the production inside the mould interior of a pressure which might force the plastic out of the chamber bounded by the core and the mould. In the position to the right of the centre line in Fig. 17, the mould 201 is in its end position in which the bore 220 is closed, by the end face of the feeder member 202, flush with the surface 207. No extra mould element or slide is therefore required to close the bore 220. Once the blank has been formed by complete closure of the mould and has been cooled to a desired temperature by contact with the possibly cooled boundary surfaces of the core and mould, the mould is disengaged axially from the core, the feeder member 202 acting as ejector and holding the blank

back on the core 212. If required, the top surface (end face) of core 212 could be formed with small recesses in the form of bores or grooves into which the plastic penetrates while the blank is being shaped, the plastic being retained on the core 212 when the mould opens. The table then rotates by an amount corresponding to the distance between two consecutive stations to bring the core 212 into a position opposite a second mould.

Referring to Fig. 18, a mould 223 cooperates with core 212 to shape the blank. The mould interior corresponding to the final shape of a cap 224 which will subsequently be formed from the blank 203 is bounded by a bore 225 in the mould 223, by the core 212 and by the annular passage 218 in the bush 213. The bore 225 is widened at the bottom to provide an aperture 226, the diameter of which is adapted to the outer diameter of the bush 213. Disposed between bore 225 and aperture 226 is an annular shoulder 227 which abuts end face 228 of bush 213 when mould 223 is in the closed position shown to the right of the centre line in Fig. 18. The mould attains the pressing position at the termination of its movement towards the stationary core. However, intermediate this movement the shoulder 227 engages the end face 228, and the bush 213 engages in the aperture 226 so that the mould cavity is closed before the shaping of the blank 203 starts. Because of the subsequent relative movement between the core and the mould 223, the mould cavity is now reduced, some of the material of the blank being pressed down over the core and entering the annular chamber 219. When the condition shown on the right-hand side of the centre line in Fig. 18 has been reached, cap 224 has reached its final shape, the plastic having been pressed. The plastic is now given intensive cooling so as not to shrink when pulled off the core. In order that the finished cap may be pulled off the plunger after the mould has opened, and in order that the rotating table may be further advanced, the core can be slightly conical at the top. While the mould is opening and while the rotating table is being advanced by one step, the sleeve 213 can be maintained in the bottom end position, then be released or forcibly pushed with assistance by the springs 214 to scrape the cap 224 off the core 212 and to eject the cap 224, for instance, through an aperture in the rotating table. Alternatively, the cap can be disengaged from the core by tongs, in which event removal is helped by the spring-loaded sleeve 213.

In the embodiments illustrated in Figs. 17—18, instead of the moulds being disposed on a rotating table a number of cores can be secured thereto and the mould set can be secured to a slide movable relatively to the cores.

The process described for producing a blank in a first shaping step can, of course, be used in the production of other articles, for instance, of tubes, in which event, however, the blank is welded to the tube during this first step.

This invention provides the following advantages:—

As compared with existing and known apparatus in which a plastic feed is shaped to final dimensions in a single shaping step by injection or pressure methods and where cooling must be very rapid in order not to lose production, the process according to the invention has the advantage that cooling is slowed down to give the plastic time to be shaped and to set. The increased cooling time does not reduce production per unit of time; indeed, the number of articles produced per unit of time can be increased considerably because the individual operations of the novel process, which determines the output, take less time than production in a single step. In the process according to the invention, the first step is shortened by that part of the cooling time which is shifted to the second and, where applicable, other steps. Another advantage of the novel process is the extra kneading given the plastic while it is being shaped. By appropriate shaping of the moulding dies, an article can be moulded in the various steps of operation and be given its final shape only in the final stage of pressing. In the novel process, an accurately determined pressure can be applied to a particular place at a particular time on one or more parts of the moulding.

In the case of two-piece articles, such as tubes, where the moulding as second part must be welded while being produced to the cold plastic element first introduced, the weld zone is of much better quality and freer from internal stresses than in previous processes when the procedure according to this invention is used of repeated compression of the plastic feed while the same is in the plastic state. The reason for this improvement is that, in the process according to the invention, the hot feed has more time to warm up the cold first-produced part and to be connected or welded thereto.

From the economic point of view, the process according to the invention reduces mould costs considerably because the moulds do not experience the heavy stressing experienced by injection moulds. More particularly, the replacement and changing of moulding are effected more rapidly and more simply than in the case of injection moulds. The cost of the moulds and the use of machinery is recovered with the novel process with shorter production runs in the

case of injection moulds. The apparatus for performing the novel process has component parts which are much lighter than in injection moulding apparatus, and so simpler and lighter apparatus based on the novel process can be used to produce plastic articles of a given weight and of given dimensions.

Another advantage of the novel process is that the moulded article leaves the apparatus without riser or flash, since the feed is accurately controlled and the pressure can be applied from various sides or at various angles. Consequently, no aftertreatment is required to remove risers or flashes.

WHAT I CLAIM IS:—

1. A method of producing a thermoplastic article, including the steps of ejecting a predetermined quantity of plastics material in a temporary state of relatively low viscosity from a hollow feeder member on to a support surface, relatively moving a die along the feeder member towards a core, such die being arranged to scrape ejected plastics material off the feeder member, closing the mould constituted at least partly by the die and the core, and moulding the article by moving the die relatively to the core into moulding contact with the plastics material.

2. A method as claimed in Claim 1, wherein the die is constituted by a plurality of die members forming a set of die members, and wherein the mould is closed and the article is moulded by moving the die members towards each other and relatively to the core.

3. A method as claimed in Claim 1 or 2, in which the article produced is subjected to at least one further moulding operation.

4. A method as claimed in any of Claims 1 to 3, in which the support surface is the internal surface of a tubular blank of plastics material supported by and projecting from the core is a direction towards the feeder member.

5. A method as claimed in Claim 4 for producing a plastics tube or container, wherein the dies is constituted by two die members and the ejected plastics material is welded to the tubular blank when the moulding operation is performed.

6. A method as claimed in Claim 4 or 5, including a first moulding operation in which the ejected plastics material is formed into a blank welded to the tubular blank, and at least one further moulding operation in which the article is completed.

7. A method as claimed in any of Claims 1 to 3, in which the support surface is the surface of the core adjacent to the feeder member.

8. A method as claimed in any of Claims 1 to 3 or 7, in which the article produced is a blank and in which the blank is subjected to at least one further moulding operation.

9. A method as claimed in any of the preceding claims, in which one core co-operates with at least two dies or sets of die members, and in which an intermediate article is produced by means of the core and the first die or set of die members, and a finished article is produced from the intermediate article by means of the core and the second or further die or set members while the ejected plastics material is still in a mouldable state.

10. An apparatus for performing the method claimed in any of Claims 1 to 9, having a core and a composite moulding device including a hollow feeder member and a die, wherein the feeder member is adapted to eject a predetermined quantity of plastics material in a temporary state of relatively low viscosity in a direction towards the core through a number of apertures at the end of the feeder member adjacent to the core, wherein the die is adapted to be moved along the feeder member towards the core and to scrape ejected plastics material off the feeder member, and wherein the die and the core constitute at least partly a mould which is adpated to be closed by relative movement between the die and the core.

11. An apparatus as claimed in Claim 10, wherein the apertures are disposed in at least one circumferential row near the free end of the feeder member.

12. An apparatus as claimed in Claim 10 or 11, wherein the die is constituted by a plurality of die members forming a set of die members and adapted to be moved towards each other and relatively to the core to close the mould.

13. An apparatus as claimed in any of Claims 10 to 12, in which a further die member is disposed on the core.

14. An apparatus as claimed in any of Claims 10 to 14, in which means are provided for relatively moving the die or die members and the core to close the mould prior to the application thereto of moulding pressure.

15. An apparatus as claimed in any of Claims 10 to 15, wherein cooling means are provided in the die or die members and/or in the core.

16. An apparatus as claimed in any of Claims 10 to 15, wherein additional means are provided for closing the mouth before the moulding pressure becomes effective, said additional means being disposed at the end of the mould remote from the core and including two plates which are adapted to move towards each other along a straight path transversely to the longitudinal direction of the feeder member, and in-

dependently of two mould members adapted to move parallel to the plates.

17. An apparatus as claimed in Claim 16 for moulding tubes, wherein the mould members serve to form the neck portion of a tube.

18. An apparatus as claimed in Claims 16 or 17, wherein the plates are shaped so as to provide, in the abutting closed position thereof, a passage for a pin disposed on the core and extending therefrom in a longitudinal direction thereof towards the feeder member.

19. An apparatus as claimed in any of Claims 10 to 18, wherein the composite moulding device is arranged to co-operate with a plurality of cores.

20. An apparatus as claimed in any of Claims 10 to 19, wherein a composite moulding device and a number of moulding dies are adapted to co-operate with a plurality of cores, and wherein at least one of the moulding dies has an interior shape different from that of the dies constituted by the moulding device.

21. An apparatus as claimed in Claim 20, wherein the moulding device can move independently of the moulding dies, and wherein the moulding dies can move only jointly.

22. An apparatus as claimed in Claim 20, wherein the moulding device and all the moulding dies can move independently of each other.

23. An apparatus as claimed in any of Claims 20 to 22, wherein a plurality of cores is disposed as a turrent and at least two dies which have different interior shapes are disposed on a circle so that each core can co-operate consecutively with each die to form a mould.

24. An apparatus as claimed in any of Claims 20 to 23, wherein all cores are identical.

25. An apparatus as claimed in any of Claims 20 to 24, wherein each core is rotatable around its axis.

26. An apparatus as claimed in Claim 10, wherein the apertures are arranged so that the plastics material ejected therethrough is deposited on the core in an annular band.

27. An apparatus as claimed in Claim 10, wherein the ejected plastics material is scraped off the feeder member by means of a sleeve engaging closely around the feeder member and having a forward edge capable of parting off strands of plastics material adhering thereto.

28. An apparatus as claimed in any of Claims 10 to 15, wherein the feeder member forms part of the closure of the mould.

29. An apparatus as claimed in Claim 13, wherein the further die member is a sleeve surrounding the core and movable relatively thereto in such manner as to close the mould before the moulding pressure is applied.

30. An apparatus as claimed in any of Claims 10 to 13 or 29, wherein the feeder member is surrounded by a resiliently mounted die member which is adapted to co-operate with the core.

31. A method of and apparatus for producing thermoplastic articles, substantially as herein described and illustrated.

WHEATLEY & MACKENZIE,
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Chartered Patent Agents.

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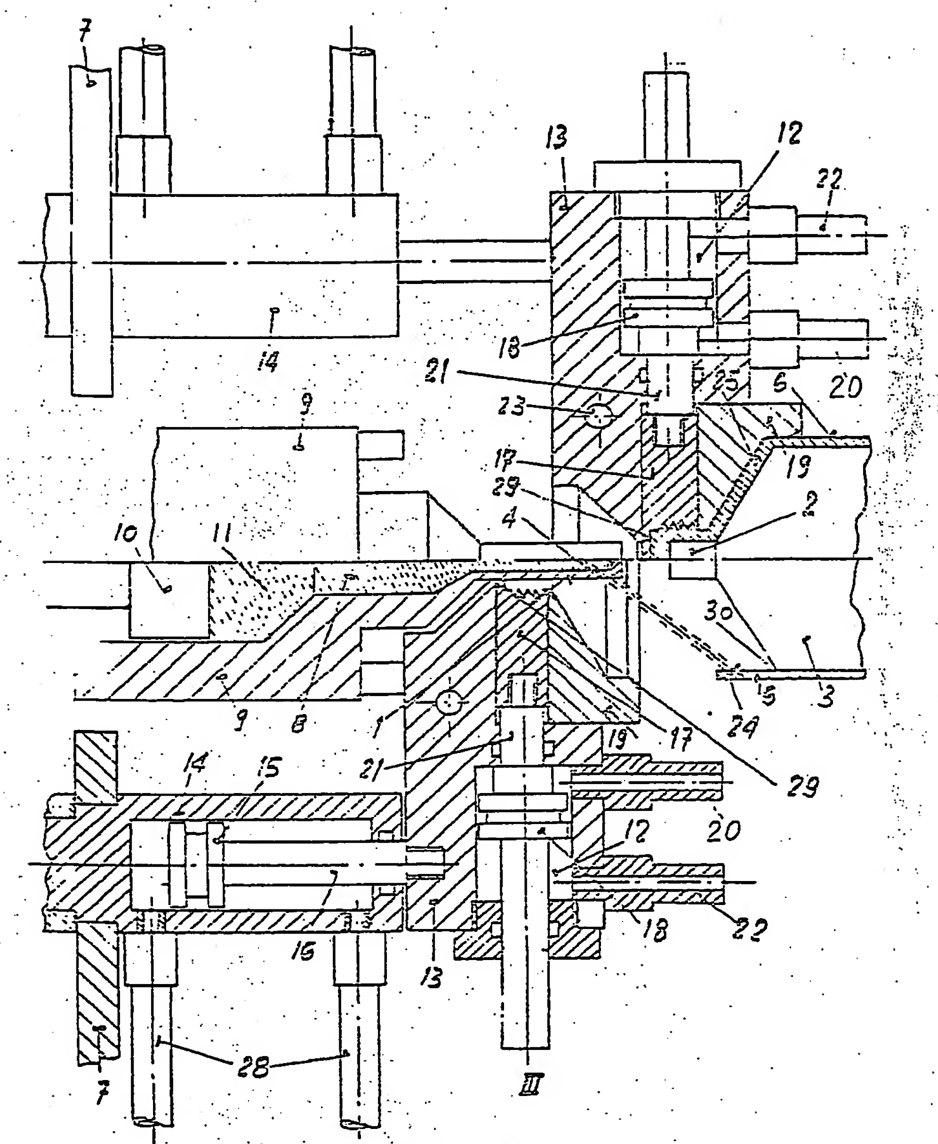
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III

FIG. 1

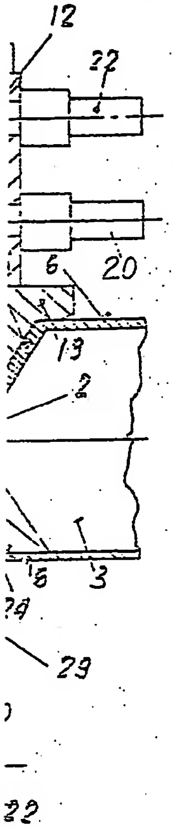
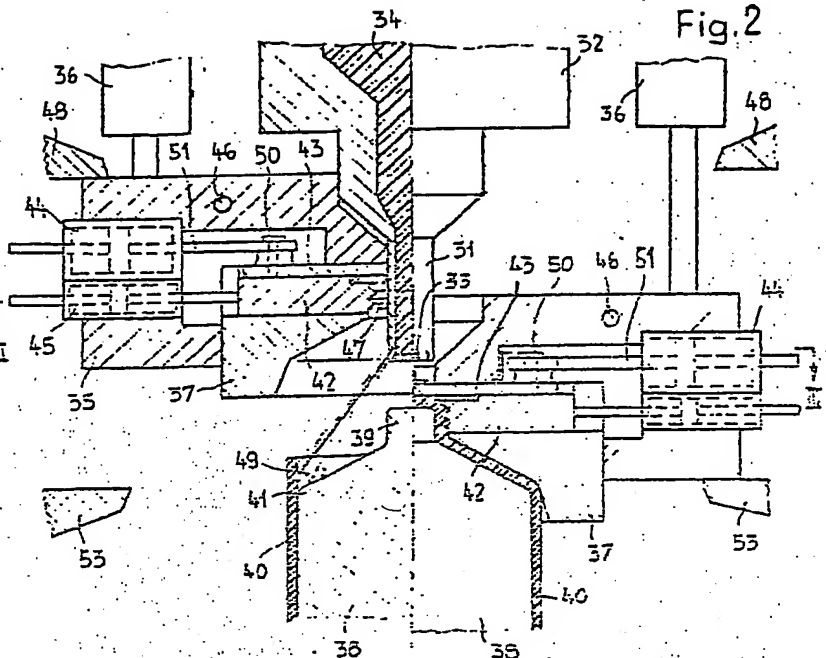


Fig. 2



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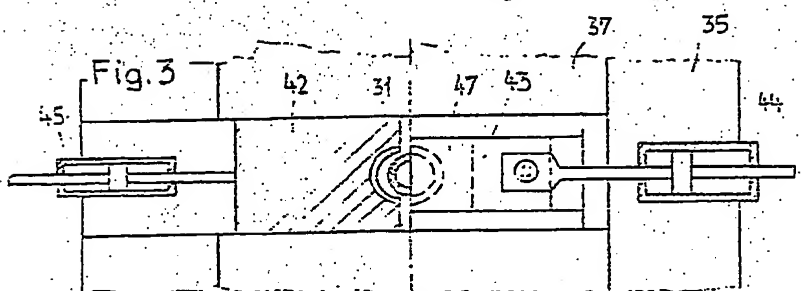
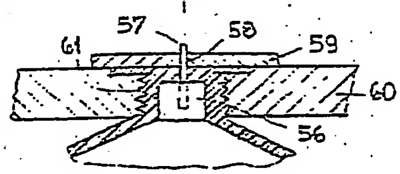


Fig. 4



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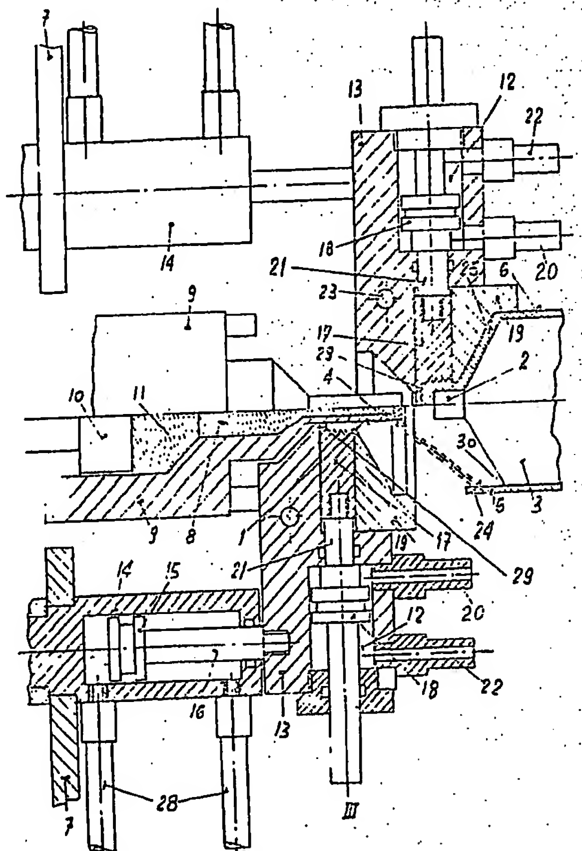
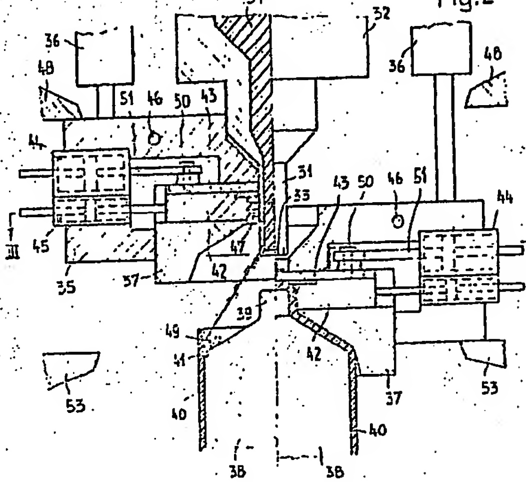


FIG. 1

Fig.2



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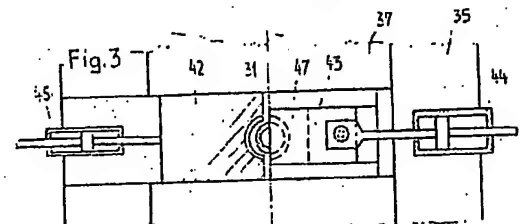

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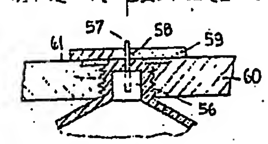

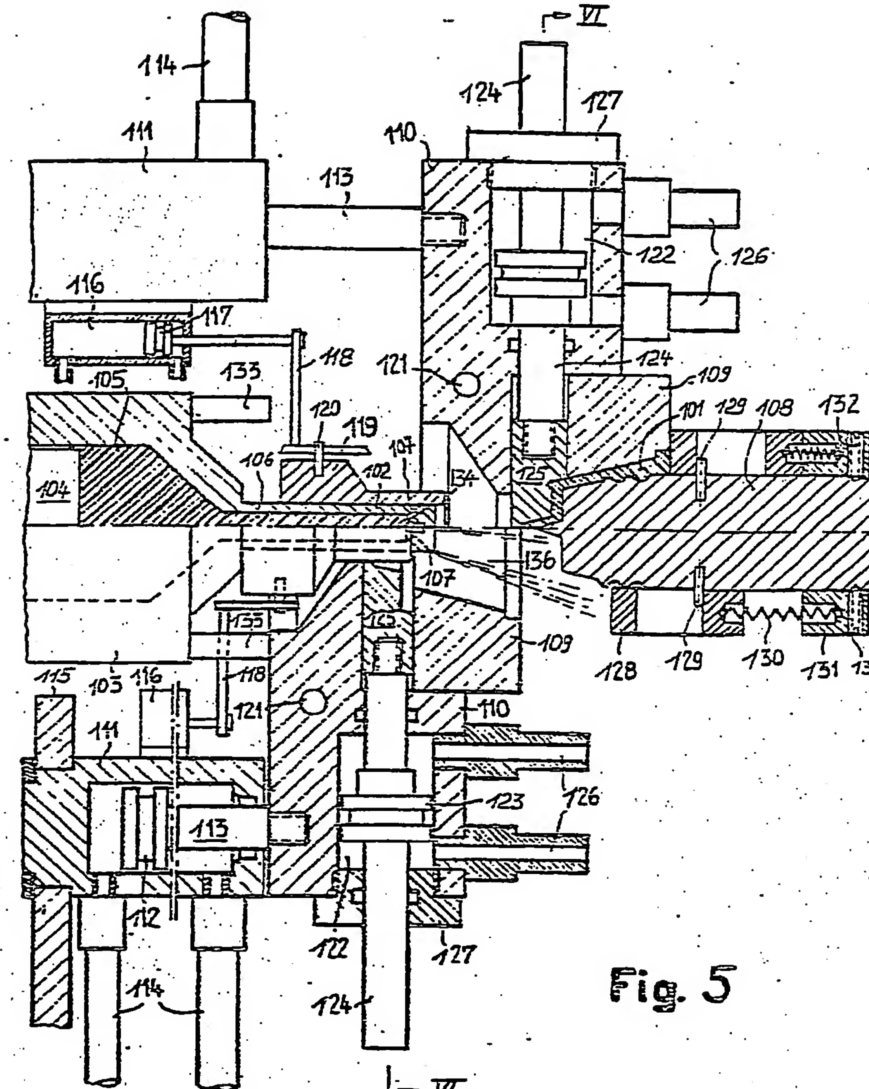
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Fig. 5

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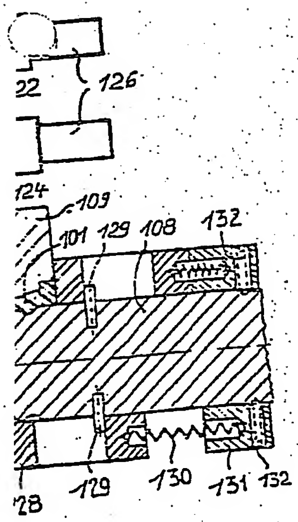

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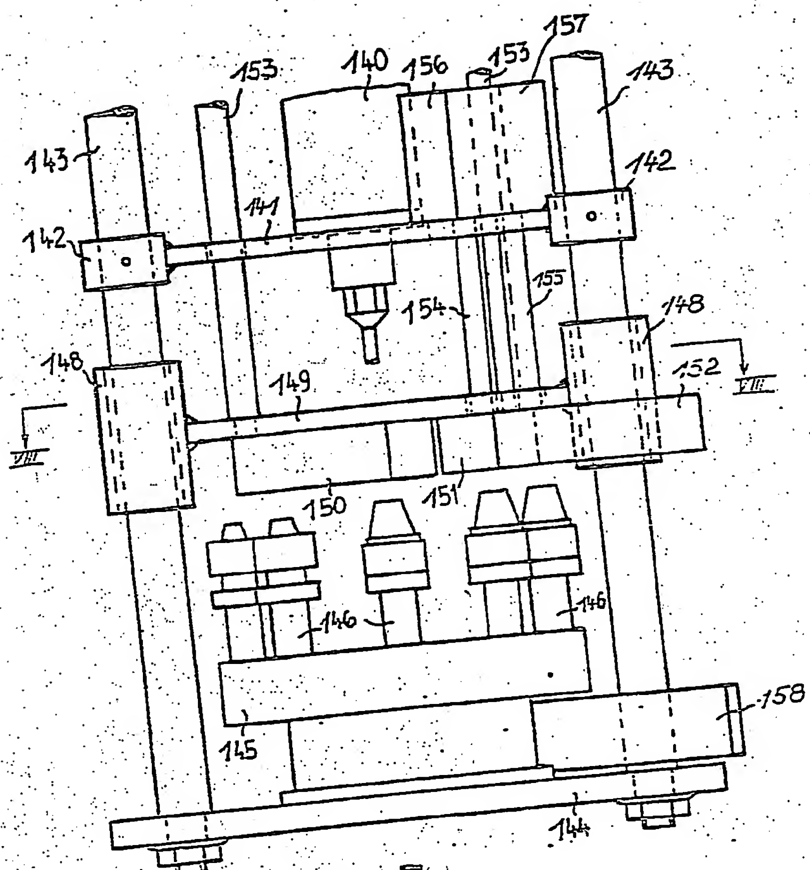

Fig. 7

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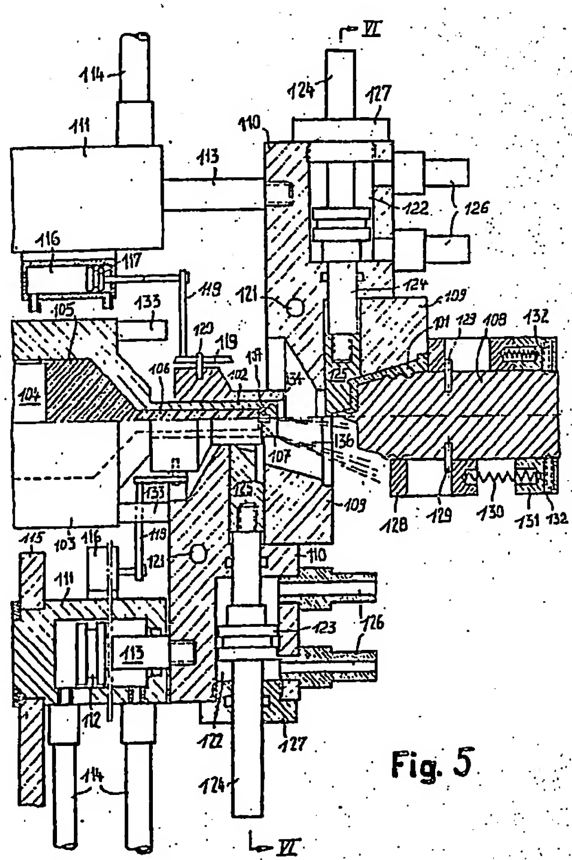

Fig. 5

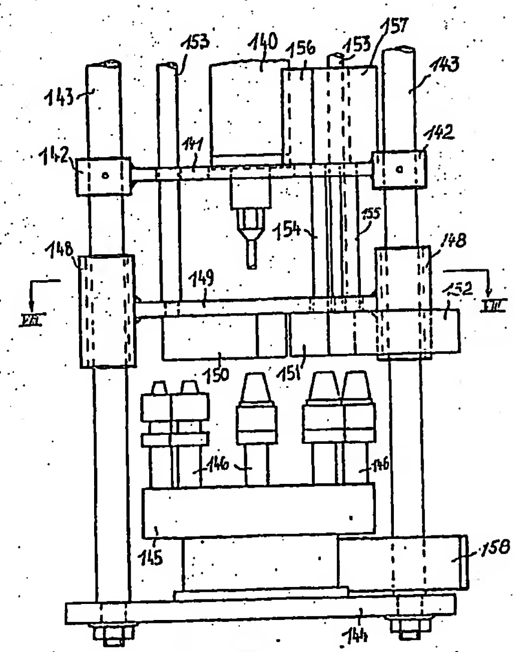

Fig. 7

Fig. 8

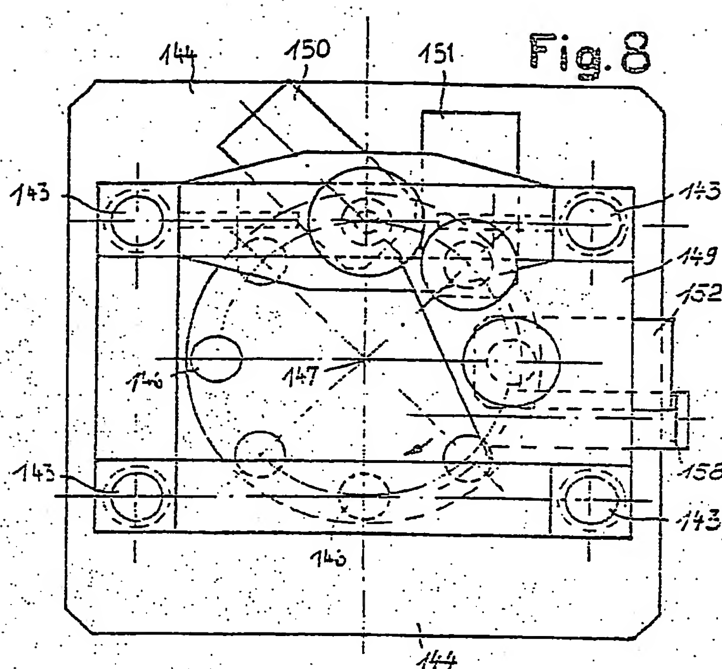
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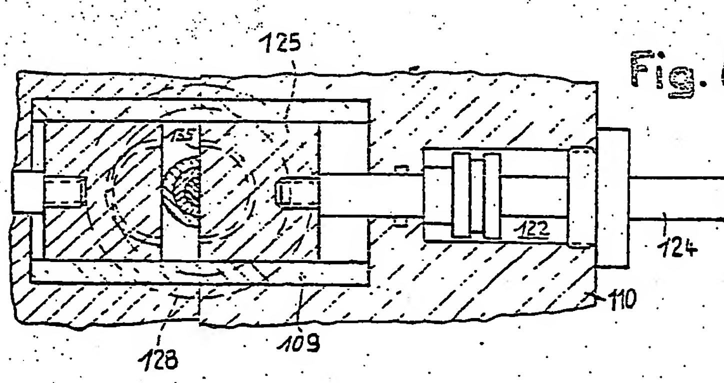
Fig. 6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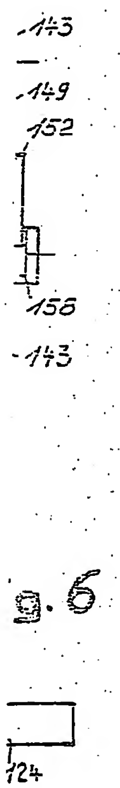
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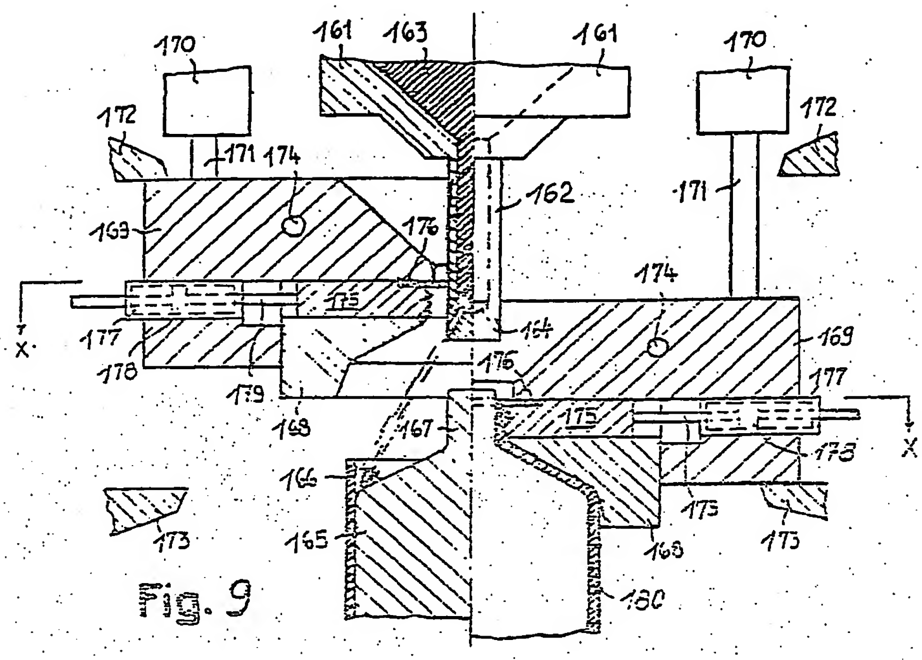
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Fig. 9

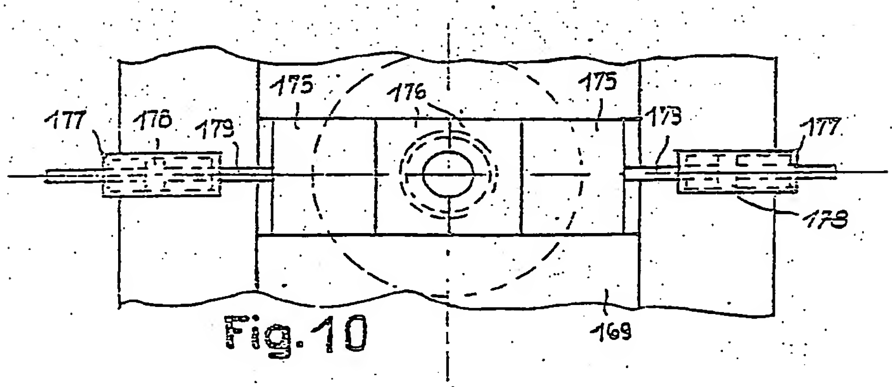
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Fig. 10

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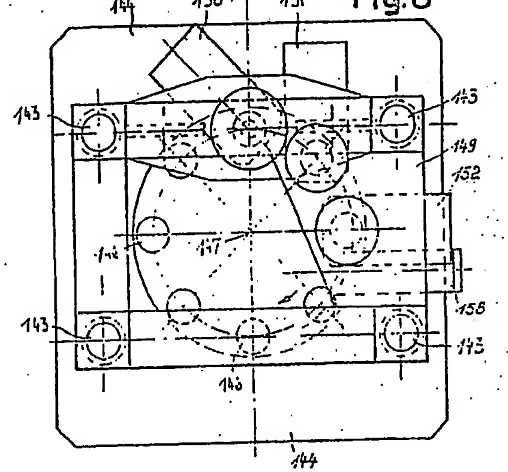

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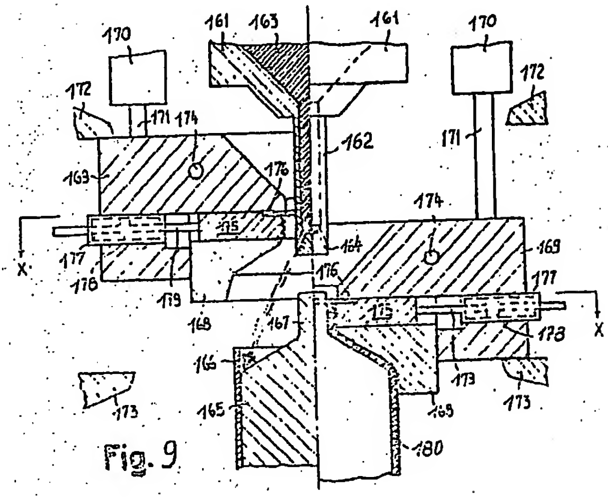

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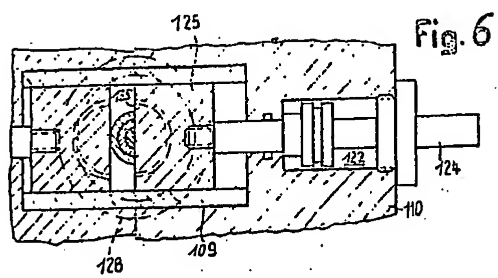

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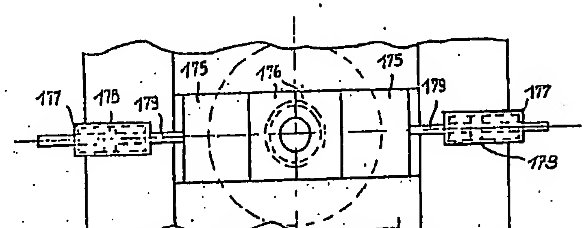

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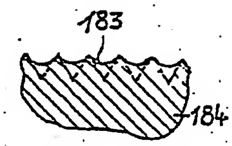

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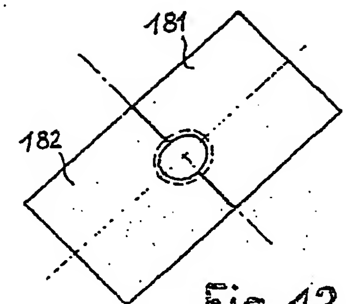


Fig. 12

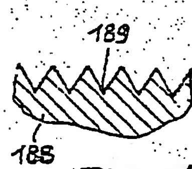
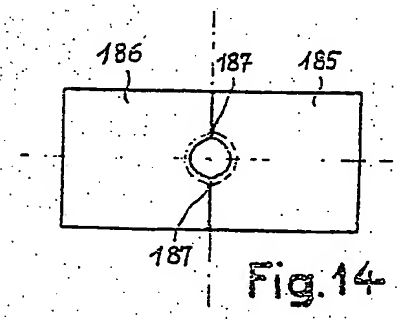


Fig. 13



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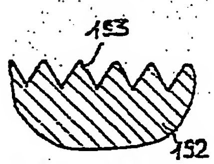

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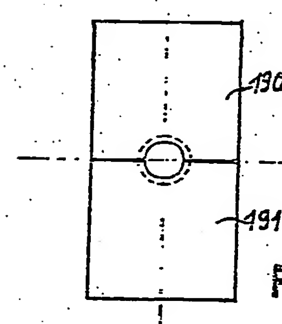

Fig. 16

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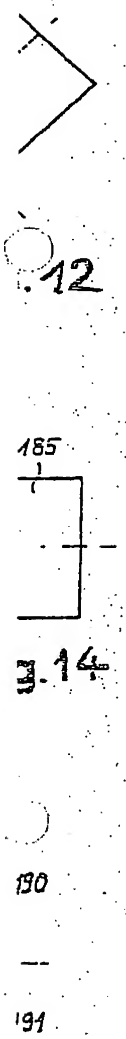
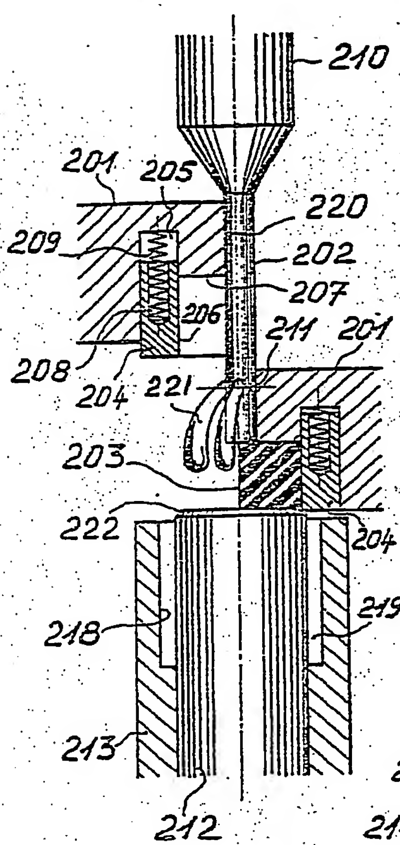


Fig.16

Fig. 17



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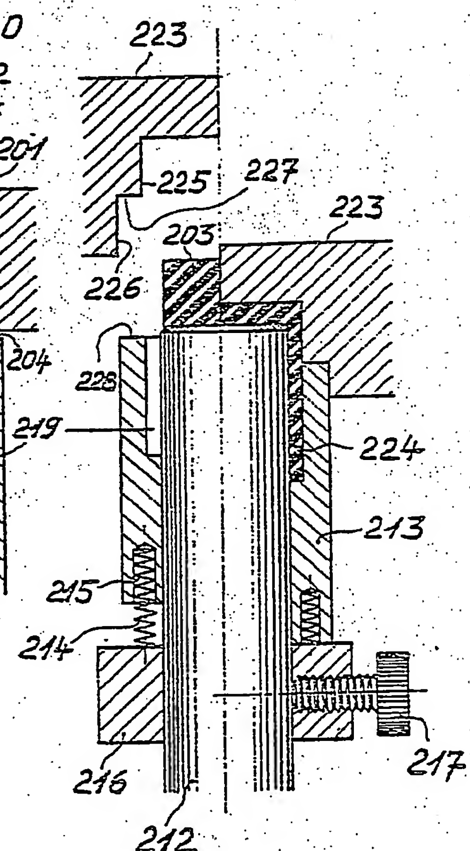

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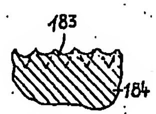

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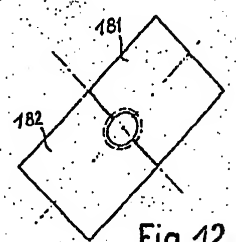

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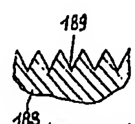

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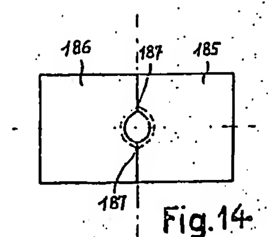

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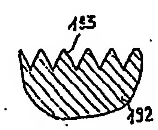

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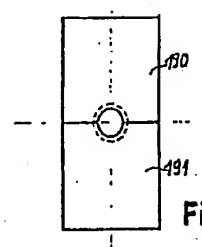

Fig. 16

Fig. 17

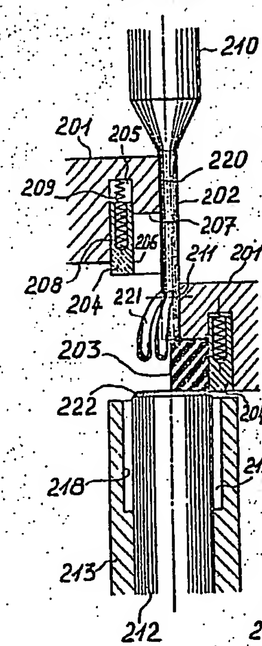

Fig. 18